What is a weed?
A plant whose virtues have not yet been discovered.
Ralph Waldo Emerson (1803–1882)
Fortune of the Republic, 1878

The Truth about the Birds and the Bees

Human activities such as agriculture, development, pesticide use, and hunting have placed the world's pollinators in jeopardy, and that spells trouble not just for the birds and the bees, but for the flowers and the trees—and for the human communities that depend on them.

Approximately 1,300 food crops worldwide, together with an estimated 90% of the 250,000 species of flowering plants, are fertilized by pollen- or nectar-gathering visits from over 20,000 species of insects, birds, bats, and monkeys, as well as one species of lizard, the gecko. Yet the only animal to receive serious attention for the vital role it plays in pollination has been the honeybee, the fruits of whose labors are an estimated $9 billion in U.S. crops. And honeybees are in trouble.

"The honeybee is the queen of pollination, but mites and invasion by African bees are causing problems," says Ron Bitner, a senior partner with International Pollination Systems, a company that markets pollinator species. Since the 1980s, wild and domestic hives in the United States have been decimated by a dual infestation of exotic parasitic mites—tracheal mites affect the respiratory tract of adult bees, and external varroa mites attack larval, pupal, and adult bees. The African bee is an aggressive variety of honeybee that was brought intentionally to South America, then escaped and spread as far as the U.S. Southwest. These bees compete with honeybees and other species for nectar, and have helped carry mites into wildlands and croplands, infecting other bees. "We're working with alkali and leaf cutter bees that are more efficient [than honeybees] in pollinating crops like alfalfa," Bitner says. "But they're not going to replace honeybees. It's not crunch time yet—we haven't seen a honeybee decline in California, for example. But if more goes wrong, [there] will be."

The decline in U.S. honeybee populations—down by 50% in the last 50 years, with 95% or more of wild hives destroyed in some areas—highlights the importance of the thousands of alternate pollinator species such as wild bees, flies, beetles, wasps, butterflies, and moths. Stephen I. Buchmann, an entomologist with the U.S. Department of Agriculture in Tucson, Arizona, and Gary Paul Nabhan, science director of the Arizona–Sonora Desert Museum in Tucson, cite figures in their 1996 book, *The Forgotten Pollinators*, showing that the current rate of decline of honeybees, combined with declines in wild pollinators resulting from human activities, could cause up to $5.7 billion in annual losses to U.S. food crops.

The effects of human activities on tropical pollinators, which include 45 species of bats, 26 species of hummingbirds, 70 species of passerine birds (perching birds and songbirds), and several species of lemurs and monkeys, have also raised concerns among conservationists. Specifically, widespread development and deforestation have led to loss of habitat, the overuse and misuse of pesticides has contributed to species declines, and a popularized fear of vampire bats has resulted in the destruction of roosting caves. Scientists say that declines in pollinators in the tropics, particularly losses of bats, can cause a cascade of effects by reducing pollination and thereby stunting biodiversity. For example, each of the world's 750 fig species is pollinated by a single species of wasp. If the fig wasps in South American tropical forests were to disappear, a cascade effect could result in the disappearance of the monkeys that eat the figs, and the jaguars and other predators that prey on the monkeys. Cascade effects involving whole ecosystems have not been observed so far.

Disappearing pollinators. Declining populations of pollinators can have economic effects on crops and environmental effects on ecosystems.

There could be human consequences as well. Bats are the major pollinators of over 100 medicinal plants, as well as over 450 economically important crops and plants used to produce fibers, dyes, and fuel valued at hundreds of millions of dollars, according to Barbara French, a biologist and information specialist with Bat Conservation International (BCI) in Austin, Texas. "Nectar-feeding bats that transport pollen are vital to the production of economically important bananas, mangoes, neem, and durian fruits," she says. "Bats also play a very significant role in insect control."

Until recently, many useful pollinators have been perceived as pests, especially bats, whose image as "vampires" and rabies carriers contributed to massive destruction of their roosts. Gaps in pollinator research haven't helped the situation. "There's been no concerted effort to collect data [on pollinators], except perhaps in agriculture, and there are few mechanisms for funding basic research," says David Inouye, a professor of biology at the University of Maryland at College Park. Funding cuts have led to the closure of four of the seven U.S. bee research labs over approximately the last 10 years.

But the future for pollinators is not entirely bleak. "We've recognized the problem [of declines in pollinator species] in time," Inouye says. Researchers are working with several substances that offer some promise against the killing mites that threaten some pollinators. The plight of such popular pollinators as hummingbirds and monarch butterflies also has helped increase the visibility of threats to pollinators. Monarch butterflies and some hummingbirds and bats are migratory, and they travel along a "nectar corridor" in which their arrival coincides with the maturation of the flowers upon which they feed. When these corridors are disrupted, the pollinators may starve. Also, migratory animals need a place that meets their food, shelter, and water needs in which to spend the winter. In the

case of monarchs, traditional wintering sites in California and Mexico have been converted by development, deforestation, or agriculture. Thus, tens of millions of monarchs are restricted to 10 sites in Mexico (5 of them unprotected by regulations) and only 7 remaining sites in California. The butterflies are not yet endangered, but a major part of their life cycle is in jeopardy.

Outreach in elementary schools has improved the public's appreciation of bats. And BCI is working with mining companies to convert abandoned mines into roosts for hibernating bats, creating a human–animal partnership with mutual benefits. "This is a very important part of bat ecology," says French. "We protect [both] the bats and people with gates at the mine entrances. It gives a habitat for bats, and helps give mines a more positive image."

Pollinators may also benefit from the move toward more "natural" gardens in private homes that demand less pesticide use, as well as a 1994 Executive Memorandum issued by President Clinton that recommends the use of regional native plants, which often evolved with their pollinators in a mutually beneficial relationship, and integrated pest management, which features reduced use of pesticides on federal and federally funded properties. And science is beginning to do its part to protect pollinators, as well. In a paper published in the February 1998 issue of *Conservation Biology*, Nabhan, Bitner, Inouye, and 19 other coauthors propose supporting animal pollinator services by promoting alternative pollinators, encouraging crop breeders to consider pollinator attraction in new varieties, preserving pollinator stocks, and researching ways of increasing pollination and creating pollinator habitats in agricultural areas.

Melanoma Vaccines

Researchers are making significant progress in developing innovative treatments for melanoma, a form of malignant skin cancer that is on the rise in the United States, according to the American Cancer Society. Melanoma begins in the melanocytes, the cells that produce the skin pigment called melanin. Researchers believe that exposure to ultraviolet light damages the DNA in these cells, which results in the development of melanoma.

Scientists have been working for years to develop vaccines that treat melanoma by stimulating the immune system to attack cancer cells. The body does not ordinarily attack melanoma cells because such cells are roughly 99% normal, says Philip Livingston, head of the cancer vaccinology laboratory at Memorial Sloan-Kettering Cancer Center in New York City. Researchers have sought to identify the differences that explain why some cells turn cancerous. "We've spent many years in the laboratory trying to define and isolate the genetic elements and the genes that code for what is different on a cancer cell compared to a normal cell that the immune system can recognize," says Steven Rosenberg, chief of surgery at the National Cancer Institute (NCI).

Livingston refers to these characteristic elements of cancer cells, which include proteins and antigens, as "handles." Researchers developing melanoma vaccines replicate these handles and combine them with immune boosters, or substances that the immune system recognizes and attacks. Theoretically, linking the handles with substances known to elicit an immune response will prompt the body to seek out all handles and therewith eliminate the cancer cells. Although the practical application of such vaccines is years away, scientists are making significant advances in the area. "This is a mammoth field," says Paul Chapman, an associate attending physician and head of the melanoma section at Memorial Sloan-Kettering Cancer Center. "There are many vaccines that are being tested, and all are equally promising."

Researchers at Memorial Sloan-Kettering are working on melanoma vaccines that contain one of three replicated chemicals—GM2, GD2, or GD3—that are located on melanoma cells and that have been found to be recognized by the immune system. The vaccines combine the chemicals with QS21, an immune booster from the South American soapbark tree, and KLH, an antigen produced by the mollusk *Megathura crenulata*. Early results show an improvement in survival rates in some patients.

Rosenberg and colleagues at the NCI have chosen to work with cancer cell peptides that the immune system can recognize. They have modified the peptides so they can better bind to the immune cells—cytotoxic T lymphocytes—that attack melanoma cells. The modified peptides are then injected into the body. In a recent study published in the March 1998 issue of *Nature Medicine*, Rosenberg and colleagues reported that, when administered with interleukin-2, a medication that boosts the immune system to help slow the growth of cancer, the vaccine caused an immune system response. They also found that 13 of 31 patients showed at least partial tumor shrinkage in the lung or skin, among other sites.

Another promising vaccine has been developed by Donald Morton and colleagues at the John Wayne Cancer Institute in Santa Monica, California. Morton collected blood, tissue, and serum samples from melanoma patients for many years. Study of these samples enabled him to identify three cancer cell lines that provoke strong immune system responses. Morton is working on a vaccine that uses radiated melanoma cells containing many different handles combined with bacillus Calmette-Guerin, a known immune booster. Morton is currently conducting worldwide clinical trials on the vaccine.

New Source of Fish Fears

In the Snook Nook bait shop in Jensen Beach, Florida, snapshots of anglers holding up their prize catches attest to the rich bounty for which the adjacent Indian River is famous. A few yards from the shop, in a cramped trailer owned by the Florida Department of Environmental Protection (DEP), is another photographic testament to the Indian River's fish. These close-up shots show fish with bloody, open sores reminiscent of those associated with the toxic dinoflagellate *Pfiesteria piscicida*.

The sickened fish in the photos began appearing early this spring on the hooks of anglers fishing around the juncture of Florida's Indian and St. Lucie rivers, a brackish region known as the St. Lucie Estuary. At least 33 species of fish were affected. Although the lesions mimic those associated with the *Pfiesteria* outbreaks that have killed millions of fish in Maryland and North Carolina, the estuary apparently harbors a different culprit; nearly all the sickened fish in the estuary were found alive.

Water samples revealed the presence of *Cryptoperidiniopsis* ("crypto"), one of 10 recognized *Pfiesteria*-like species of microalgae. Karen Steidinger, a senior research scientist, and Jan Landsberg, a research scientist, both of the DEP's Florida Marine Research Institute in St. Petersburg, first identified crypto in 1997 in water samples taken from St. John's River near Jacksonville. Like *Pfiesteria*, crypto is a heterotrophic dinoflagellate that feeds on microalgal prey. Crypto coexists with *Pfiesteria* in Maryland and North Carolina, but appears to live apart from any related species in Florida.

Whether it's causing the ulcers in the St. Lucie fish, though, is not clear. Of the 2,000 known species of dinoflagellates, about 65 have been shown to produce toxins. "There's no evidence [crypto] is toxic," says JoAnn Burkholder, an associate professor of botany and aquatic ecology at North Carolina State University in Raleigh, who in 1991 helped identify *Pfiesteria*. "We don't understand much about toxin pro-